Draft – RSMP Streams QAPP Addendum

May 27, 2015

Subcommittee discussion: Brandi Lubliner, Chris Konrad, Curtis DeGasperi, Cami Apfelbeck, Chad Larson, Glenn Merritt, Jess Archer, Karen Dinicola

Note to reviewers: This document includes tentative identification of roles and responsibilities for each set of analyses and questions: a team of authors and analysts with a lead. Next step is scope of work: schedule, deliverables and budget. Small groups will get together and flesh those out, get a better handle on tasks and level of effort. Curtis will lead these discussions.

Table of Contents

Introduction

This addendum to the "Quality Assurance Project Plan for Status and Trends Monitoring of Small Streams in the Puget Lowland Ecoregion Monitoring Conducted using Pooled RSMP Funds contributed by Western Washington Municipal Stormwater Permittees" (RSMP Small Streams QAPP) (Lubliner, 2014), provides the approaches to assess Regional Stormwater Monitoring Program (RSMP) small streams monitoring data and the intended reporting outcomes. This addendum also updates site information identified in the RSMP Status and Trends Small Streams Monitoring QAPP; see Tables 3 and 4 and Figure 1 of this updated document. Minor corrections and updates to the QAPP sections ____*Brandi will fill in*____ are also included.

The RSMP is monitoring 100 small stream sites in the Puget Lowlands for monthly water quality and discharge and a one-time summer collection of benthic macroinvertebrates, habitat, periphyton and sediment, spanning the 2015 calendar year. RSMP sites were randomly selected using a Generalized Random Tessellation Stratified (GRTS) survey design, the details of which can be found on the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) website. The primary reason a randomized study design was selected for the RSMP small streams, was to allow for a regional summary assessment of stream condition. Fifty sites each are located within and outside Urban Growth Areas (UGAs).

The Stormwater Work Group (SWG) convened a special subcommittee to develop an addendum to the monitoring QAPP that would describe the approach to data assessment and reporting for answering priority questions. The SWG agreed that the following priority questions should be answered by analysis and interpretation of RSMP small streams data:

1. What percent of streams meet biological, water, and sediment quality standards for beneficial uses within and outside UGAs?
2. What natural variables correlate with the status of streams within and outside UGAs?
3. What human variables correlate with the status of streams within and outside UGAs?
4. What water, sediment, biological, and habitat parameters should be carried forward for trend assessment of RSMP stream monitoring in the future, and at what timing and frequency?

The SWG also agreed that it is important to discuss, investigate, and learn from these questions:

- How does RSMP compare with other monitoring programs in Puget Sound?
- How do RSMP status and trends monitoring, effectiveness studies, and source identification and diagnostic monitoring support each other.
- What are the authors' overall recommendations for future rounds of RSMP stream sampling; i.e., what information about streamflow, stream habitat and health, and ancillary/explanatory data will make the RSMP status and trends effort most meaningful/useful to stormwater managers?

Communication and Reporting

Each section below includes specific needs for reporting the findings of the analyses intended to answer the above questions. Results will be presented to tell a regional story rather than a site, or reach, story. In addition to traditional published reports, this project will include web reporting, summary fact sheets, and reporting to Salmon Recovery teams to provide relevant results on habitat condition. The authors will give early presentations to jurisdictions and/or SWG, and incorporate feedback and suggested analyses into final products. Regional partners may answer other questions using the RSMP data set.

Status Assessment of Puget Lowland Stream Quality and Habitat

A status evaluation of water, sediment and biological quality will be made for the Puget Lowland Ecoregion as a whole, and for each assessment strata: Within Urban Growth Areas (WUGA), and Outside Urban Growth Areas (OUGA). A substantial effort will be made to explain the status evaluation based on information about natural and human factors.

One of the first steps in preparing the data for a regional assessment is to determine the relative weighting of the sampled sites in context of the available sites within the ecoregion, this is called weighting. Specifically, weighting will determine the length of stream miles sampled (sample population) out of the total stream miles that also fit the selection criteria (total population); USGS and EAP have this information. Status assessment methods are available from Ecology (Merritt and Hartman, 2012), national (EPA) wadeable streams reports, and the work of local governments. For example, King County has R scripts for calculating confidence intervals on probability (DeGasperi ref) and the recent WRIA report (http://www.kingcounty.gov/environment/wlr/sections-programs/science-section/doing-science/wadeable-streams.aspx) includes relevant analysis methods.

Comparison to Criteria and Beneficial Uses

Comment [KD1]: Brandi has some initial information about what is needed to get the data into shape to use in the analyses

Water, sediment and benthic macroinvertebrate data will be used to answer the first question on status of the streams meeting aquatic life criteria in Washington freshwater (WAC 173-201A) and freshwater sediment (WAC 173-204-563). Beyond the freshwater sediment SQVs, a literature review will include the AquaTox (USEPA) database and Canadian freshwater statutes which have functional thresholds where Washington standards don't exist. This data will be compared at both the individual stream level and "rolled-up" as a categorical group for the assessment strata (within and outside UGAs). Where various designated beneficial uses have multiple water quality standards, data will be summarized to tell the broader story.

A Water Quality Index (WQI) score (Hallock, 2002) is typically based on a 5 year moving average, where a value of 80 or greater is considered to meet water quality standards. However most of these RSMP small stream sites will have only one year of data. Sites will be evaluated and ranked for comparison against criteria for WQI, but the short record taken into consideration. A categorical evaluation will be explored.

In addition, a wide range of "predictor variable" data will also be compared to the gathered response variables (water and biological quality), for the purposes of answering these questions:

1. What percent of streams meet biological, water, and sediment quality standards for beneficial uses within and outside urban growth areas (UGAs)?
2. What natural variables correlate with the status of streams within and outside the UGA?
3. What human variables correlate with the status of streams within and outside the UGA?

Natural predictor variables will include geomorphology, recent climate, flow characteristics, basin size, substrate, habitat metrics, position in the watershed, riparian and forest cover, and likely others. Human activity predictor variables may include land use or land cover (impervious area or traffic density), permitted and urban areas, restoration, and stormwater retrofit activities. These data sets are listed in Table x. A relative/attributable risk approach will be employed for this evaluation.

Additional explanatory information for human impacts will be gathered during other related phases of this project, so this will not be the only exploration of these impacts.

Table x. Geographic data sets needed for post-stratification analysis

GIS Data Types	Sources	Useful for category		
		Water Qa/Qx	Sediment quality	Biological quality
General geographic information: basin areas, NHD HiRes, REV100kStrahler, salmon recovery regions, ecoregions, cities, gages, permit coverage, WQ assessment areas, beneficial uses, TMDLs	Ecology, USGS	x	x	x
Land use/Land Cover: standard categories, riparian widths, change over time analyses, land use index, human disturbance	NLCD2011, Ecology, WDFW	x	x	x
Road use density (AADT), stream crossings	Ecology, WSDOT, Counties	x	x	x
Outfalls	Permittees and Ecology	x	x	
Wetlands	Ecology, WDNR	x	x	x

Supplemental ancillary data sets may also be used to conduct a relative risk/attributable risk or a signal to noise analysis on complimentary datasets from the Puget Sound Lowland ecoregion for the RSMP basins and strata. Ancillary data sets are listed in Table y.

Comment [KD2]: Maybe bring an example of this to the Freshwater Workgroup meeting: predictors and priority areas of focus. Some uncertainty about whether/how to focus on natural versus human factors for predictors of condition. Both are relevant. Want to know which are most important. Also, whether reach level or landscape level information is most useful.

Data analysis tools will include the use of R stats, Access, Excel, or other programs to produce summary statistics, graphics (boxplots, charts), and tables.

Table y. Ancillary data sets needed for comparative analysis

Sources of Information	Data Type Category		
	Water quality & quantity	Sediment quality	Biological & habitat quality
Cities, Counties, Ecology, Tribes, citizen science	x	x	x
DOH, Health Districts, WA DNR	x	x	
DOH, Health Districts, WA DNR			
USGS, NOAA, EPA	x	x	x

Reporting the findings

The final report will focus on the findings most useful to stormwater and resource managers. This means saying what we know or can say to explain the findings. Tell the audience what watersheds are doing well, which are doing poorly, and provide explanation if evident in findings.

1. Present the overall findings for the extent of impairment, or most interesting parameters, then stories about beneficial uses (plus compelling parameters).
2. Present findings in an indirect/direct gradient context, using the multiple datasets to contrast reference conditions to conditions outside UGAs and to conditions inside UGAs.

3. Focus on what GIS or ancillary information correlates with findings. What we know or can say about why. Relative risk/Attributable risk.
4. De-prioritize report sections about predictable or undetected problems. Data can be scored using percentiles relative to reference condition or standards.

The team of authors will include: Curtis DeGasperi (King County), Chris Konrad (USGS), Chad Larson (Ecology) and Leska Fore (PSP). Additional analyses will be performed by ~~Chad Larson~~ Glenn Merritt (Ecology) and Markus Von Prause (Ecology). RSMP Coordinator Brandi Lubliner will support the authors.

Comment [KD3]: Some GIS work is being done right now – USGS is delineating basins. Brandi will update folks in the small group discussions.

Comment [KD4]: Curtis will convene the next steps discussions among the authors and any others from the FWG who are interested.

Comment [KD5]: This section involves somewhat redundant effort to the first – want them to work together. We can pare down the repetition but need to come up with timeline and tasks.

Integrating information from other stream monitoring programs

Other monitoring programs in the region collect information on stream quality that can be used by the RSMP in the assessment of the 100 sites in Puget Lowlands in 2015. This section describes the potential benefits of integrating monitoring data from other regional programs into the analysis of RSMP data and the methods that will be used to evaluate the utility of this approach.

Purpose for integrating information from other programs: Streams in the Puget Sound region have been monitored extensively through local, state, tribal, and federal programs. The information collected by these programs is valuable for assessing the status and trends in streams, which is the primary goal for RSMP stream monitoring. Other programs offer information that can inform the RSMP assessment in four respects:

- Local hydrography (maps of streams and drainage systems) is likely a more accurate representation of the population of streams in the region and their associated drainage area;
- Additional sites increase the spatial coverage of monitoring information to address the geographic distribution of stream quality;
- Multiple sampling events over time including long-term monitoring information can be used to identify trends; and
- Additional parameters may provide a more complete description of stream quality.

This information can be used for both the substantive assessment of stream quality status and trends and the development of recommendations for future RSMP monitoring.

Approach and Methods

Integration of information from other monitoring programs in the RSMP status and trends assessment has five main tasks.

1. Document selected other stream monitoring programs that collect information on stream quality directly relevant to answering the RSMP assessment questions:
   There are many programs in the Puget Sound region that collect information about stream quality including water, sediment, and biota. A list of accessible databases with stream quality information will be compiled for review, including at a minimum: Ecology's Environmental Information Management database (EIM), the Puget Sound Stream Benthos database, and USGS and EPA databases. Some of this information may be useful to the RSMP, but only if it is directly relevant to RSMP assessment questions (as informed by the findings of the status assessment), well-documented, and readily accessible for multiple sites (e.g., U.S. EPA 2015; U.S. Geological Survey

2015a, 2015b; Washington Department of Ecology, 2015a; http://www.pugetsoundstreambenthos.org/).

Methods documenting data collection and quality assurance/quality control procedures will be reviewed for each data source. Incomplete datasets, which lack site/sampling information or documentation of methods, will be excluded from the compilation. Substantial discrepancies, for example, in sampling techniques, analytical methods, or detection limits, will be noted.

Criteria for including sites in the comparative analysis will be developed based on the site selection (random, targeted), dates/frequency of sampling, and parameters reported. Criteria will be "tiered" where, for example, one tier could include sites having one record with field parameters (e.g., temperature, pH, conductivity) and another tier could be sites with multiple B-IBI values over a decade. Given the large number of possible combinations of parameters and sampling histories, the number of tiers will be limited to about 5 representing a range from synoptic sites with basic parameters to long-term sites.

2. Compare and contrast the spatial coverage of RSMP and other monitoring programs:
The coverage of stream monitoring programs will be described in terms of locations and basin characteristics. A GIS layer of sampling points and delineation of the upstream watershed area will be prepared for sites meeting criteria, with comparisons of the amount of upstream watershed area represented and amount of overlap. The high resolution National Hydrography Dataset (Washington Department of Ecology, 2015b) will be used as the spatial framework. As a preliminary step, maps of streams with flow designation (perennial/ephemeral) and drainage basins will be requested from state agencies and local jurisdictions. In areas where flow designations have not been determined, the flow status will be estimated from available information including streamflow data, surficial geology indicating the likelihood of aquifer discharge, and drainage area. Basin characteristics such as upstream watershed area, mean basin elevation, %Urban, %Forest will be compiled for each sampling location. Significant gaps in terms of locations and types of basins will be identified.

3. Compare the condition of streams monitored by other programs to RSMP findings:
A primary goal of RSMP stream monitoring is to characterize the distribution of stream conditions in the region. The status results from the RSMP 2015 sampling (discussed as the first topic of the QAPP addendum) would be compared to results of other stream quality programs based on random sampling (e.g., Merritt and Hartmann, 2012). For univariate measures, the comparison would use the approach of Rhen and Ode (2009) except that:
    a) Only programs using random sampling would be considered, and
    b) The performance measures would be percentages of streams in good, fair, and poor condition, and
    c) The authors will determine whether to assess the cumulative distribution of stream conditions.

In these cases, statistical tests will be used to ascertain the probability that the distributions are the same (the null hypothesis). A relatively high probability value (e.g., $p = 0.1$) will be used as the standard for significance to increase the power of the test to detect differences between results (Helsel and Hirsch, 1997). Additionally, due to the multivariate nature of some of the data collected (e.g. species data), multivariate homogeneity of group dispersions (variances) can be conducted to test for differences between programs employing random sample designs (Anderson 2006). If programs represent distinct time periods, trend tests will be applied (e.g., Konrad and Booth 2001). A comparison of cumulative distributions might provide a good visual comparison of similarities and differences in results between programs.

The viability of inferring stream condition from targeted sampling will be considered by generating stream condition distributions from targeted samples using basin characteristics to weight individual sample values. As with the comparison of random programs, a relatively high probability value will be used to increase the power of any statistical tests to detect differences between distributions

A similar analysis with no weighting (and possibly with no weighting of RSMP metrics) may be conducted following Rhen and Ode (2009), if no particular weighting scheme shows promise.

A spatial stream network statistical model might be developed from targeted sampling data for a few of the most potentially useful parameters to potentially improve the spatial representation of the targeted data. Combined with the probabilistic sample data, this might be an even more useful tool for identifying cause and effect relationships and informing management actions.

4. Discuss other status and trends questions that can be answered with available information: Temporal variability of parameters: robust monitoring depends on parameters that have relatively low temporal variability relative to their expected response to management. A table comparing the spatial (across-site) and temporal (at-site) variance of key parameters will be prepared.

   Factors that distinguish sites with distinct stream condition can be used for stratifying sampling in the next round. Classification and regression trees (CART) (Therneau et al. 2015) will be applied to identify any factors that can be used to classify stream quality; or the authors may consider boosted regression trees (see http://www.ncbi.nlm.nih.gov/pubmed/17489472 and http://onlinelibrary.wiley.com/doi/10.1111/j.1752-1688.2011.00632.x/abstract) as an alternative to CART.

5. Explore other possibly relevant monitoring done by environmental groups and other citizen science (i.e., Stream Team), local land trusts, Watershed Councils, Dept. of Health, and local health districts.

Reporting the findings

The final report will focus on the findings most useful to stormwater and resource managers:

1. Overall findings for the discovery survey of ancillary data.
2. Relative risk assessment approaches that can guide relating key RSMP status and trends data to key local basin activities in a manner conducive to local adaptive management.
3. What additional data need to be compiled for the next round of status and trends monitoring data analysis and interpretation?

The team of authors will include: Curtis DeGasperi (King County), Chris Konrad (USGS), Leska Fore (PSP).

Comparison to other monitoring programs

Comparison to other probabilistic monitoring programs

Comment [KD6]: Need to prioritize what programs' data are compiled (might reference Ecology's water quality assessment). Also might do a prototype watershed or two.

RSMP small streams sites were chosen from the Washington State Master Sample which was created using EPA's generalized random-tesselation stratified (GRTS) design. In the Pacific Northwest, there are a handful of stream monitoring programs that are also based on this same randomized study design. Monitoring data can be easily compared among these programs, given there is overlapping geographic domains, and the programs used the same protocols (Larsen, et al. 2007). The SWG and the Freshwater Workgroup (FWG), both working committees of the Puget Sound Ecosystem Monitoring Program (PSEMP), recommend comparing results of the RSMP small streams data to other existing probabilistic

monitoring program data. Below are the other monitoring programs collecting data under this framework that will be evaluated for comparability:

- City of Redmond and Pierce County Stream Monitoring Programs collect small stream data in an identical manner as RSMP streams as a permit requirement. Site selection was different in that it is locally densified, thus results are specific to their jurisdiction.
- Ecology's Watershed Health Monitoring Program has strata for Puget Sound Ecoregion that will be compared to the RSMP streams data. The sentinel and reference sites that are sampled for the statewide monitoring will also be explored.
- Lower Columbia Habitat Status and Trends Monitoring Program is a coordinated monitoring program under development in the Lower Columbia River Basin of Washington State. The monitoring sites are selected from a GRTS master sample. A drainage-area-based criterion is applied to screen sites for suitability. Water quality metrics were determined by signal-to-noise "grades" and applicability to stormwater assessment questions. Data collection will not begin until sometime after 2018, but the approach is worth considering here.
- Other States' and National probabilistic programs. Data are available for 13 states (Arizona, California, Florida, Iowa, Kansas, Missouri, New Hampshire, New Jersey, South Carolina, South Dakota, Tennessee, Vermont, Wyoming). http://ofmpub.epa.gov/waters10/attains_status.state_status

Initial steps to compare probabilistic monitoring programs will include a comparison of site selection methods and sampling protocols. If found comparable, the data from RSMP small streams can be compared to the above programs, or the data combined to extend the time range and investigate similarities or differences in the data sets. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) study design tool will be used to store and compare RSMP methods, protocols, and site design to other programs. For example, this analysis will also allow us to compare the status of streams in the Puget Sound Lowland ecoregion, both within and outside UGAs, to Ecology's sentinel and reference site results. This will provide a meaningful assessment of change over very long timeframes and the ultimate gage of impact due to cumulative long-term pressures such as climate and land use changes in the last 100 years.

Another intended evaluation between these programs is to evaluate if as a region, we can combine our data and cooperate for more efficient monitoring. For example, coordinate with Salmon Recovery teams to provide relevant results on habitat conditions in the Puget Lowlands.

Comparison to non-probabilistic (targeted) monitoring programs

RSMP small streams monitoring design was chosen such that results represent the entire Puget Lowlands Ecoregion. Many targeted (non-probabilistic) stream monitoring programs exist in Washington State and the comparability of these programs to the RSMP is unknown. Some local jurisdictions collect extensive stream datasets, and in terms of methods and protocols may be very similar to the RSMP.

Water quality, benthos, or sediment data from a select set of targeted stream monitoring programs will be collected and compared to the RSMP stream data: Local Governments, Environmental Groups, Watershed Councils, Health Districts, Department of Health, State agencies, USGS.

The approach to the analysis is to create four groups: within UGA, outside UGA, and a random vs targeted data set. Water, sediment and benthos will be evaluated monthly, seasonally, annually for each of the four groups. Correlations with predictor variables, landscape variables, seasonality, time periods, among others will be evaluated.

Reporting the findings

Comparison to other probabilistic monitoring programs: The final report will focus on the findings most useful to stormwater and resource managers. This means saying what we know or can say to explain the findings:

1. Present the overall findings on similarities and opportunities for combining data sets. Where data are available, use an approach similar to that outlined for the status assessment and highlight any new findings evident from including these new data sets.
2. If, in the future, other cities and counties want to follow or contribute: what methods and protocols are similar enough to make data and results comparable?

Comparison to non-probabilistic targeted monitoring programs: The final report will focus on the findings most useful to stormwater managers:

1. Present findings succinctly for major/minor differences or no differences in the data comparisons between RSMP and targeted programs for each grouping.
2. Consider how to present the quality of the differences, if any, in terms of effort spent to gather the data. Make some inferences on cost/benefit of various data types and the utility of using some or all data from existing programs in lieu of collecting new data.

The team of authors will include: Curtis DeGasperi (King County), Chris Konrad (USGS), Leska Fore (PSP).

Relating status and trends to effectiveness and source control

Comment [KD7]: This section/analyses may move forward as a separate effort.

Citizens and governments residing in the Puget Lowlands Ecoregion employ a myriad of efforts to identify and eliminate pollutants, restore and enhance habitat, and reduce stormwater impacts to receiving waters. It is generally agreed that collectively these actions should have a positive impact on water and habitat quality, and, thereby, have a positive impact on the status and trends results at the RSMP monitoring locations.

However, it is unknown how informative tracking and inventorying these actions within the immediate drainage area to RSMP stream monitoring sites can be to interpreting status and trends assessment results. Conversely, it is unknown how much regional status and trends can inform adaptive management strategies at the local level.

This effort will lead to a more in-depth understanding of local basin activities and, ultimately, explore the relating status and trends results to local activities in the drainage basin.

Goals and approach

1. Discover and summarize major restoration and management efforts for stormwater. The goal is to assess what stormwater management actions are tracked and whether they are tracked in a format that can be easily used by the RSMP (e.g., using a spreadsheet, database, or GIS). The desired outcome would be an understanding the major types of actions being implemented to reduce the impacts of stormwater. Note, such a list or summary may already exist; members of the SWG should be queried first about summary information before conducting a broader summary.
    a. Initially, the most readily available is used for the status assessment (see the ancillary data listed in the section below). Then the RSMP may conduct additional discovery survey(s) and summarize existing data related to implementation and monitoring of restoration and

management actions. Primarily these actions include source control activities, municipal stormwater/sanitary sewer system corrections, BMP implementation, and restoration projects

b. Identify areas that have or will have before and after sampling from the RSMP status and trends program or other monitoring programs.
c. This task could utilize the Source Identification Information Repository SIDIR Results and Findings data base being compiled in 2015, survey Ecology permit managers to find what data has already been provided by permittees, query the Environmental Report Tracking System (ERTS), or be a direct survey of municipalities and other agencies.

2. Match restoration and management actions to potential data sources with relevant information to assess the implementation, scale, local effectiveness and regional effectiveness of the actions.

   There is a potential to conduct a risk assessment to identify key parameters and corresponding actions that are useful for informing local adaptive management. EPA developed a statistical method for ranking the relative risk associated with various stressors using probabilistic sampling data, and King Co has applied this approach to evaluate relative risks to stream invertebrates of various regional stressors. This analysis should be taken further to evaluate the primary stressors to a variety of endpoints we care about, e.g., stream invertebrates, mussels, and fish. These data are available but have not been analyzed in this way and would provide insight into where we should focus or management actions and evaluate their impact.

   This could be a larger contract to determine which data streams could be used to evaluate the effectiveness of regulatory, restoration and management actions to reduce the impact of stormwater.

   As data and results from RSMP effectiveness studies become available, the relevance of local studies need to be made relevant to the regional recovery effort. Depending on the study, some modeling of potential impact may be needed. Results from studies and regional modeling need to be summarized and communicated to people making decisions on related topics.

3. Refine our questions. This would be a small contract to host a process to develop logic models to connect actions to outcomes and identify what is known, what is not known and what we can measure at each step from implementation of actions, to reduction of environmental pressures to recovery of biological endpoints.

Any outcomes need to be carefully vetted by municipalities to ensure that the questions asked are relevant to their work. For example, tracking a variable we cannot change is not helpful; in contrast, determining which actions are most cost effective at a regional scale is helpful.

Ancillary source control and restoration data sets needed for relational analysis

The following types of data will be needed.

Municipal Stormwater System (MS4) operation and maintenance:

- MS4 cleaning and vactoring, street/parking lot sweeping, pond maintenance, treatment and flow control inspections, ditch maintenance, road repair

Illicit Discharge Detection and Elimination (IDDE) and Environmental Report Tracking System (ERTS):

- Spills/illicit connections that resulted in a discharge to a receiving water

Sanitary sewer system source control actions:

- Combined sewer overflows (CSOs)
- Identification, replacement, and/or maintenance of confirmed failed septic systems
- Identification and correction of cross connections

Other source control actions:

- Inspections and/or technical assistance programs in industrial, commercial, agricultural, and residential areas
- Confirmed toxic spills and/or toxic cleanup actions
- Confirmed food/ hazardous waste handling violations and/or corrections

Restoration actions:

- Stream habitat restorations and enhancements
- Culvert replacement/ removal and drainage improvements
- MS4 Retrofits (including Low Impact Development (LID))
- BMP effectiveness monitoring (RSMP and other)

Reporting the findings

The final report will focus on the findings most useful to stormwater and resource managers:

1. Compelling stories of clear or likely connections between actions/events and conditions.
2. Overall findings for the discovery survey of ancillary data; highlighting what is new to the project compared with what was collected and used for the status assessment.

The team of authors will include: ~~Cami Apfelbeck (City of Bainbridge Island) and~~ Chris May (Kitsap County).

Recommendations for the next round of RSMP stream monitoring

The analyses described in this QAPP addendum are intended to support the development of recommendations for the next round of monitoring under the RSMP. The objectives for future monitoring will be determined by the SWG. In order for those objectives to reflect understanding gained from the analyses of 2015 RSMP monitoring and other programs, the various section authors will collaborate to make specific, tangible recommendations. This collaboration should be supported by the PSEMP Freshwater Work Group.

After considering the findings from the 2015 RSMP data and comparison with other programs, the authors will provide collective recommendations as to what information is needed and desired for the next round of RSMP stream monitoring, including (but not limited to):

- Candidate sites to be sampled;
- Parameters/media the SWG should consider adding to the RSMP to provide a more complete description of stream quality and biotic health;
- Parameters/media the SWG should consider dropping from the RSMP due to lesser value for a specific reason, i.e., a low signal to noise ratio or frequent non-detection;
- Frequency and timing of sampling:

    - Every two, four, or five years for various parameters/media to support trends analysis; and
    - Timing within the year to make the data most meaningful
- Streamflow monitoring priority gaps, and an assessment of the utility and success of using stream stage monitoring as a proxy for discharge; and
- Additional ancillary information needed to support RSMP data interpretation and provide more direct feedback for stormwater management program effectiveness.
- Any recommendations for improved integration/coordination with other monitoring efforts, such as salmon recovery.

Comment [KD8]: Follow up with Rich Sheibley on where pressure transducers are located and how to use stage data.

Once the SWG has considered these recommendations and confirmed objectives for the next round of monitoring, the specific information needed to address those objectives and a monitoring design will be developed.

Streamflow monitoring recommendations for RSMP small streams

Prior analyses have improved our understanding of the stream gaging network in Puget Sound and its gaps. The recent USGS lowland stream gaging reports (Konrad and Voss, 2012 and Konrad and Sevier, 2014) identified all gages in the Puget Lowlands and characterized the types of streams represented and not represented by the current network.

Specific questions that remain include:

- Which current stream gaging locations are most useful/necessary to maintain for answering regional status and trends questions?
- What additional stream gaging locations are needed to fill the highest priority gaps?
    - How many sites (in total) should be monitored long-term?
    - Should the new sites be random, targeted, or a combination of the two?
- How should the data be collected: by traditional gages, staff gages, pressure transducers, or another technology?
    - What is the estimated collective cost of the additional stream gauges needed?

The most useful flow characteristics for informing regional stormwater management are yet to be defined. The report will highlight this element, characterize what is collected in RSMP small streams monitoring and compare that to what other flow data exists. Where possible flow metrics will be calculated and used in the exploratory analysis.

Trend monitoring recommendations for RSMP small streams

The 2015 RSMP small streams data collection effort captures a wide range of parameters. Based on the data analysis for status assessments and comparisons to other monitoring efforts, what are the recommended changes to the streams monitoring effort to become more relevant, efficient and purposeful in answering stormwater management impact questions?

In particular results from comparisons to standards, relative risk/attributable risk effort, signal to noise analyses, and comparisons to other probabilistic or targeted programs will be discussed. The goal will be to discern valuable parameters for the future RSMP small streams trend program. Recommendations for parameters and also frequency of the various RSMP small stream monitoring components (flow, bug, water quality, sediment quality) will be made.

Recommendations will also be made for what ancillary/explanatory data need to be gathered.

Finally, the Lower Columbia Habitat Status and Trends Monitoring Program design (Lando and Booth, 2015) will be reviewed and the study design (site selection and metric selection approaches) will be considered for making recommendations for trends monitoring.

Reporting the findings

The final report will focus on making recommendations that will result in future findings that will be most useful to stormwater and resource managers. If some recommendations coming out of the analyses listed above are in conflict or would compete for resources, then the report will discuss a rational approach to resolving and recommending an action.

The team of authors will include: Curtis DeGasperi (King County), Chris Konrad (USGS), Leska Fore (PSP).

References

Anderson, M.J., 2006. Distance-based tests for homogeneity of multivariate dispersions. Biometrics 62: 245-253.

Hallock, D., 2002. A Water Quality Index for Ecology's Stream Monitoring Program. Washington State Department of Ecology, Olympia, WA. Publication No. 02-03-052. https://fortress.wa.gov/ecy/publications/summarypages/0203052.html

Helsel, D.R. and R.M. Hirsch, 1997, Statistical Methods in Water Resources, Elsevier.

King County, 2015. http://www.pugetsoundstreambenthos.org/. A website developed by a four Puget Sound lead agencies to allow collaborative database system that allows sharing of benthic macroinvertebrate data among more than 30 organizations and provides tools for calculating metrics and indices.

Konrad, C.P. and D.B. Booth, 2002, Hydrologic trends associated with urban development for selected streams in the Puget Sound Basin, western Washington, U.S. Geological Survey Water Resources Investigations Report 02-4040.

Konrad, C.P. and F. Voss, 2012, Analysis of Streamflow-Gaging Network for Monitoring Stormwater in Small Streams in the Puget Sound Basin, Washington, U.S. Geological Survey Scientific Investigations Report 2012–5020. http://pubs.usgs.gov/sir/2012/5020/

Konrad, C.P. and M. Sevier, 2014, Physiographic and Land Cover Attributes of the Puget Lowland and the Active Streamflow Gaging Network, Puget Sound Basin, Washington, U.S. Geological Survey Data Series 815. http://pubs.usgs.gov/ds/815/

Lando, J.B. and D.B. Booth, 2015. Complete reference.

Lubliner, 2014. Quality Assurance Project Plan for Status and Trends Monitoring of Small Streams in the Puget Lowlands Ecoregion for Monitoring Conducted using Pooled RSMP Funds contributed by Western Washington Municipal Stormwater Permittees. Washington State Department of Ecology, Olympia, WA. Publication No. 14-10-054. https://fortress.wa.gov/ecy/publications/SummaryPages/1410054.html

Merritt, G. and C. Hartman, 2012. Status of Puget Sound Tributaries 2009: Biology, Chemistry, and Physical Habitat. Washington State Department of Ecology, Olympia, WA. Publication No. 12-03-029. https://fortress.wa.gov/ecy/publications/summarypages/1203029.html

Rehn, A.C., and P.R. Ode, 2009, Synthesis report: integrating probability and targeted survey designs in regional stream condition assessments with examples from southern coastal California, California Department of Fish and Game.

Therneau, T., B. Atkinson, and B. Ripley, 2015, An introduction to recursive partitioning and regression trees using the RPART routines, http://cran.r-project.org/web/packages/rpart/vignettes/longintro.pdf.

U.S. Environmental Protection Agency, 2015, STORET Data Warehouse, http://www.epa.gov/STORET/dbtop.html

U.S. Geological Survey, 2015a, National Water Information System, http://waterdata.usgs.gov/nwis

U.S. Geological Survey, 2015b, Water Quality Technical Memorandums, http://water.usgs.gov/admin/memo/QW/

Washington Department of Ecology, 2015b, National Hydrography Dataset, http://www.ecy.wa.gov/services/gis/data/inlandWaters/nhd/NHDdownload.htm

Washington Department of Ecology, 2015a, Environmental Information Management, http://www.ecy.wa.gov/eim/